MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, SESSION 2016/2017

EEL4126 – POWER SYSTEM OPERATION AND CONTROL

(LE)

26 MAY 2017
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question Paper consists of four pages including the cover page with four Questions only.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

a) Draw the block diagram and explain procedures of Economic Operation. [4 marks]

b) Three generators have the following hourly cost of power.
$C_1 = 0.032P_1^2 + 2.0P_1 + 240$ RM/h; $50MW \leq P_1 \leq 96MW$
$C_2 = 0.024P_2^2 + 2.4P_2 + 120$ RM/h; $70MW \leq P_2 \leq 144MW$
$C_3 = 0.016P_3^2 + 3.6P_3 + 120$ RM/h; $60MW \leq P_3 \leq 120MW$

i) Calculate the optimal loading of the generators to supply a load of 240 MW. Also find the expenditure per day. [5 marks]

ii) If the loading of the generators are equal, find the extra expenditure per day compare it to optimal loading cost at 240 MW load. [4 marks]

iii) If the loading of the generators are proportional to their ratings, find the extra expenditure per day compare to optimal loading cost at 240 MW load. [4 marks]

iv) Which combination of units should be used to supply a load of 170 MW most economically? [8 marks]

Question 2

a) Name 6 types of methods in Unit Commitment Problem solutions. [6 marks]

b) A four bus power system is shown in Figure Q2b. Line reactances (in pu) are $x_{12} = x_{13} = x_{14} = 0.2$; $x_{23} = x_{24} = 0.25$ and $x_{34} = 0.333$. Bus 4 is a reference bus.

i) Write the DC load-flow matrix. [6 marks]

Calculate;

ii) The generation shift factors for line1-2 for trigger of generator-1. [3 marks]

iii) The generation shift factors for line1-2 for trigger of generator-2. [3 marks]

iv) The generation shift factors for line1-2 for trigger of generator-3. [2 marks]

v) The line outage distribution facto for line 2-3 for an outage of line1-2. [5 marks]

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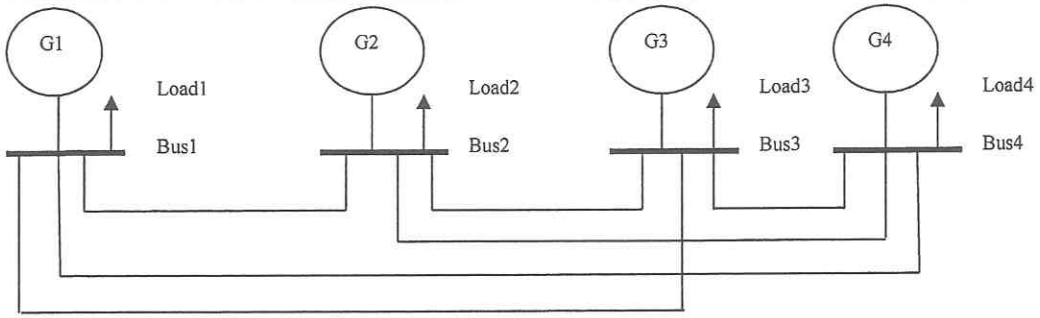

Fig. Q2b

Question 3

a) The data below belong to three generators which are connected to a load bus of a 50 Hz system. The load on the bus increases to 150 MW.

i) Calculate the new generation in each unit to compensate the 150 MW increment if the percent change D is taken equal to zero and the base MVA is taken as 500. [6 marks]

ii) Calculate the new generation in each unit to compensate the 150 MW increment if percent change D =1 and the base MVA is taken as 1000. [6 marks]

For your calculations apply 6 decimal points where applicable.

Generator	MVA rating	Speed droop R (pu on generator base)
1	100	0.01
2	500	0.015
3	500	0.015

Generators	The initial load on the generators in MW
P1	80
P2	300
P3	400

b) What are the three main objectives of Automatic Generation Control? [3 marks]

c) Table Q3c represents data for two areas in a power system which are connected by a tie-line, and are operating at frequency of 50 Hz.

Table Q3c

	R, pu	D, pu	Base MVA
Area-1	0.01	0.8	800
Area-2	0.02	1.0	400

Continued...

If an increase of 80 MW load occurs in Area 1,

i) Calculate the new steady state frequency and change in tie-line power flow [3 marks]

ii) Calculate the changes in prime mover powers [6 marks]

iii) Comment on the total change in generation. [1 mark]

Question 4

a) The following parameters belong to an AVR system of a generator:

	Amplifier	Exciter	Alternator	Sensor
Gain	K_A	1	1	1
Time constant	0.1	0.4	1.0	0.05

i) Draw the AVR block diagram [4 marks]

ii) Write the equation of the closed loop transfer function for this system [5 marks]

iii) Calculate the steady state error for the unity step response if the amplifier gain is 20. [3 marks]

b) What are the functions of an excitation system used for synchronous machines? [3 marks]

c) Draw a functional block diagram of a large synchronous machine excitation system and explain the function of each block. [10 marks]

End of Paper.